NASA TT F-9096

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N71-71336
(ACCESSION NUMBER)
5
(PAGES)
(NASA CR OR TMX OR AD NUMBER)
(THRU)
None
(CODE)
(CATEGORY)
FACILITY FORM 602

Translation of "Installation d'essais des Laboratoires de Mécanique des Fluides de l'Université de Grenoble."
Comptes Rendus des séances de l'Académie des Sciences.
Vol. 256, pp. 5052-5054, Session of June 1963.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON SEPTEMBER 1964

# TESTING EQUIPMENT AT THE FLUID MECHANICS LABORATORIES OF THE UNIVERSITY OF GRENOBLE

René Moreau

ABSTRACT

Description of a mercury loop to be used in experiments with various types of laminar and turbulent flows in the presence of a uniform transverse magnetic field.

The testing equipment installed at the Fluid Mechanics Laboratory at the University of Grenoble aims at contributing to the filling of the great need for experimental results that has been stressed by numerous authors in magnetohydrodynamic research. The fluid used is mercury, and the area of research is that of the smaller values of the Reynolds magnetic numbers.

The general arrangement of the circuit is shown in Figure 1. Impelled by a centrifugal pump, the fluid flows through a tunnel of rectangular section placed in the air gap of an electromagnet. Fluctuations in flow are avoided by means of two constant-level tanks placed on the entrance and discharge sides of the tunnel. Two separate entrances have been provided, which makes it possible to study phenomena of confined as well as mixed jets. A water-cooled heat-exchanger at the discharge side of the pump prevents a temperature rise of the mercury that might cause an evaporation sufficient to have harmful effects. An electromagnetic flowmeter is installed on the return pipe to the pump. The various metal parts of the circuit are of 18-8 stainless steel, which is nonmagnetic and is not attacked by the mercury.

Figure 2 shows a crosssection of the test tunnel in position in the electromagnet, the tunnel's uniform interior section for flow of the mercury being 5 by 16 cm. The two vertical walls of the tunnel are composed of two plates of stainless steel 4 mm in thickness, which are lined with a sheet of lucoflex to insulate them electrically from the mercury. A solid block supports the assembly and serves as the bottom wall of the tunnel. Holes through it connect to a differential pressure gauge for observing static pressures. The walls are held together by screws, the tightness of the joints being achieved by an 'araldite 123-B' gasket. The top wall of the tunnel is made of a stretched flexible band of 0.3 mm thickness that is integral with the test-well carriage in its

longitudinal movement (Figure 3). At the beginning, the bottom and top walls are not electrically insulated, so that they allow the lines of force of the electrical field to close outside of the portion of the tunnel through which the mercury flows.

On top of the tunnel and in a housing filled with mercury is the mechanism shown schematically in Figure 3 for displacing the test-well in three dimensions.

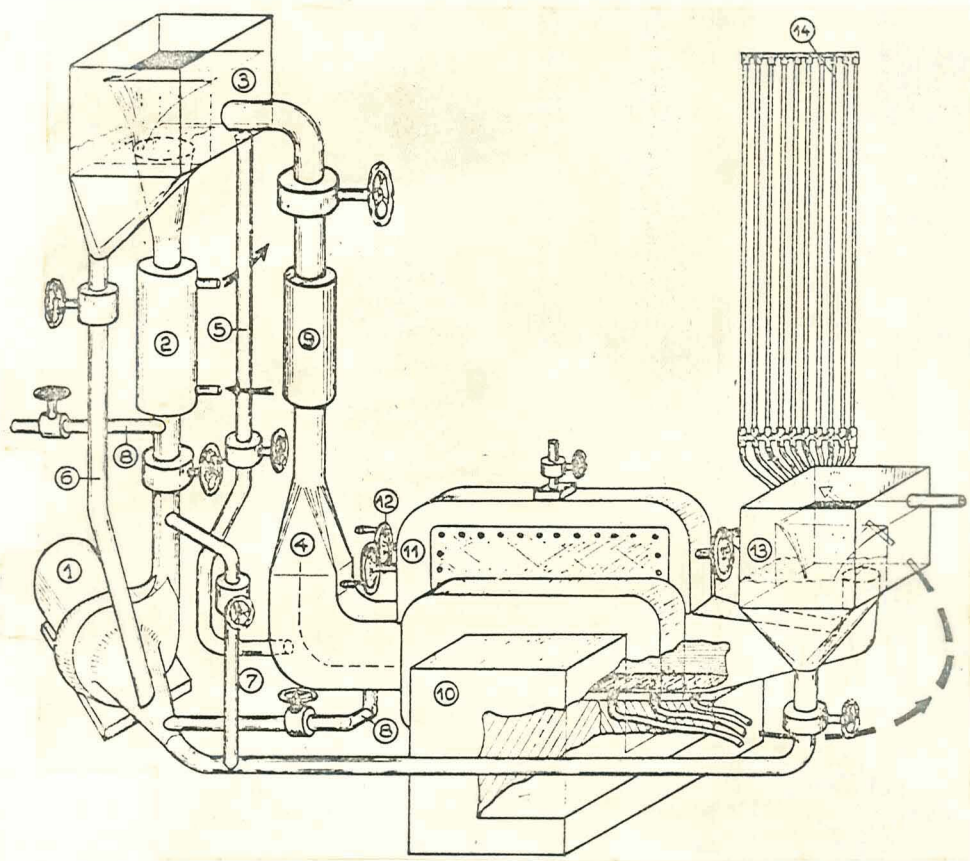


Figure 1: 1) centrifugal pump; 2) heat-exchanger; 3) constant-level intake tank; 4) primary flow; 5) secondary flow; 6) overflow; 7) bypass; 8) circuit drain; 9) electromagnetic flowmeter; 10) electromagnet; 11) housing; 12) driving gear for displacing test-well; 13) constant-level discharge tank; 14) differential pressure gauge.

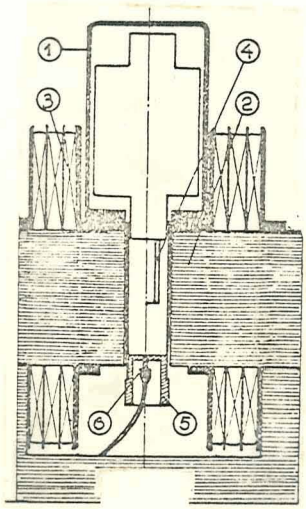


Figure 2: 1) housing; 2) magnetic core; 3) winding; 4) test-well; 5) supporting block; 6) connections for obtaining static pressures.

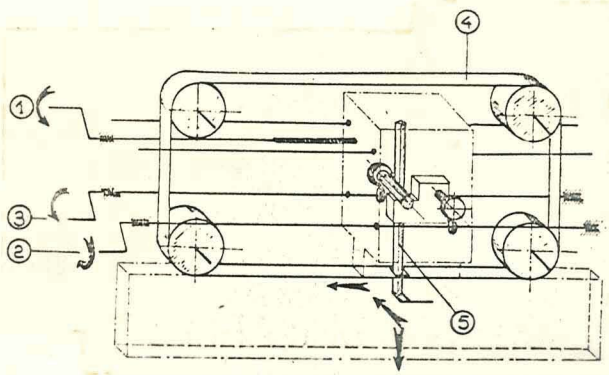


Figure 3: 1) longitudinal displacement; 2) transverse displacement; 3) vertical displacement; 4) band attached to the carriage; 5) test-well support.

The electromagnet's magnetic cores, which are made of 'Pompey APS5 steel,' form an air gap 6 cm wide by 20 cm high by 56 cm long. The field is produced by six windings cooled by water circulation; they can be connected in series or in parallel at will, and are fed with dc current from a 5-kw converter.

The principal characteristics of this equipment as given below have been calculated by assuming as characteristic length, half the width of the tunnel, or 2.5 cm.

Reynolds number: 0 to 150,000.

Reynolds magnetic number: 0 to $1.5 \cdot 10^{-2}$.
Hartmann number: 0 to 500.
Maximum flow: 4 l/sec.
Maximum field of induction: 10,000 Gauss.

In order to evaluate the exact possibilities of this equipment, it should be added that it allows the study of laminar and turbulent flow patterns through conduits (with uniform rectangular section, bidimensional divergent and convergent) as well as free flow (confined jets in the presence of an external flow, slip streams, mixtures).

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Translated for the National Aeronautics and Space Administration by John F. Holman Co. Inc.